Fishery Data Series No. 93-7

Creel Surveys Conducted in Interior Alaska During 1992

by

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ABSTRACT

Creel surveys were conducted on three of the major fisheries within the Tanana River drainage, Alaska, during 1992. These fisheries included (1) Chatanika River whitefish spear fishery, (2) Fielding Lake Arctic grayling *Thymallus arcticus* sport fishery, and (3) Salcha River chinook salmon *Oncorhynchus tshawytscha* sport fishery. Angler effort, harvest and the distribution of harvest of whitefish by angler trip, and angler demographics was estimated for the Chatanika River whitefish spear fishery. The distribution of satisfaction ratings of Arctic grayling harvested by anglers in each Relative Stock Density (RSD) category and in each age class was estimated at the Fielding Lake Arctic grayling fishery. Angler demographics along with effort, catch, and harvest were estimated for the Salcha River chinook salmon fishery.

At the Chatanika River, spear fishermen expended a total of 1,239 hours (SE = 16) to harvest an estimated 1,898 (SE = 49) least cisco *Coregonus sardinella*, and 392 (SE = 9) humpback whitefish *Coregonus pidschian*. Sixty-one percent (SE = 1.3) of all spear fishers harvested at least one or more whitefish.

Angler satisfaction ratings generally increased with each increasing Relative Stock Density (RSD) category and with increasing age for Arctic grayling harvested at Fielding Lake.

The creel survey at the Salcha River chinook salmon sport fishery was conducted from July 10 through the July 24, at which time the fishery was closed by emergency order. During this period anglers expended an estimated 1,820 (SE = 439), angler-hours of effort to catch a total of eight (SE = 4) chinook salmon, of which 4 (SE = 3), were harvested.

KEY WORDS: Creel survey, catch, harvest, angler effort, angler ratings, distribution of harvest, angler demographics, interior Alaska, Tanana River drainage, Arctic grayling, *Thymallus arcticus*, humpback whitefish, *Coregonus pidschian*, least cisco, *Coregonus sardinella*, chinook salmon, *Oncorhynchus tshawytscha*.

INTRODUCTION

The Arctic-Yukon-Kuskokwim (AYK) Region encompasses an area that covers almost two-thirds of the State of Alaska and includes all of Alaska north of Bristol Bay and the Alaska Range (Figure 1). Within this area, the state's largest river systems (Yukon, Kuskokwim, Colville, and Noatak) are found. These waters support a large number of recreational fisheries for both resident and anadromous fish species that include Arctic cisco *Coregonus autumnalis*, Arctic char *Salvelinus alpinus*, Arctic grayling *Thymallus arcticus*, anadromous chinook salmon *Oncorhynchus tshawytscha*, anadromous and land-locked coho salmon *O. kisutch*, anadromous chum salmon *O. keta*, burbot *Lota lota*, Dolly Varden *S. malma*, humpback whitefish *C. pidschian*, lake trout *S. namaycush*, least cisco *C. sardinella*, northern pike *Esox lucius*, rainbow trout *O. mykiss*, round whitefish *Prosopium cylindraceum*, and sheefish *Stenodus leucichthys*.

For sport fishery management, the AYK Region was divided into two areas, the Tanana River drainage and the AYK area (all waters excluding the Tanana River drainage; Figure 1). Even though the AYK Region encompasses a large area, the majority (approximately 75%) of the recreational angler-effort and harvest occurs near the major population centers (Fairbanks, Delta Junction, and Tok) within the Tanana River drainage (Mills 1979-1992; Figure 2).

From 1977 through 1982, harvest of all fish species increased about 19% annually to a peak of about 179,000 for the Tanana River drainage (Mills 1978-1983). A record harvest for the entire AYK Region, of 274,541 fish occurred in 1982 (Figure 2). From 1983 to 1987, harvest decreased in both the Tanana River drainage and AYK Region. The decrease in harvest that occurred in 1983 was probably the result of the overharvest of the major species (Arctic grayling, lake trout, burbot, northern pike) in the Tanana River drainage in prior years. Because of this decline, restrictive management regulations were instituted for the major fisheries in the Tanana River drainage in 1987 and 1988. In spite of restrictive regulations, harvest and angler effort increased in 1988. Harvest of all sport fish species in the Tanana River drainage dropped by 5% from 1988 to 1989, and more than 31% from 1989 to 1990. During this same period effort levels continued to rise from 1988 to 1989 and then decreased slightly from 1989 to 1990. While effort decreased a second straight year from 1990 to 1991, harvest in both the Tanana River drainage and the AYK area increased by 19 and 27%, respectively, during this same time. The stocking program in interior Alaska continued to contribute significantly to the sport harvest. Data obtained from the Statewide Harvest Survey (Mills 1992) indicate that stocked rainbow trout account for nearly 50% of all fish harvested in the Tanana River drainage, and that the contribution from all stocked species made up more than 66% of the fish harvested.

Monitoring of the Tanana River drainage recreational fisheries is important to evaluate the effectiveness of the stocking program, and to assess the consequences of newly-imposed restrictive regulations on indigenous stocks. Conservation of indigenous stocks is desired in interior Alaska, through use of restrictive regulations and by diverting fishing pressure to stocked species. One method of assessing the success of conservation efforts is through the use of creel surveys.

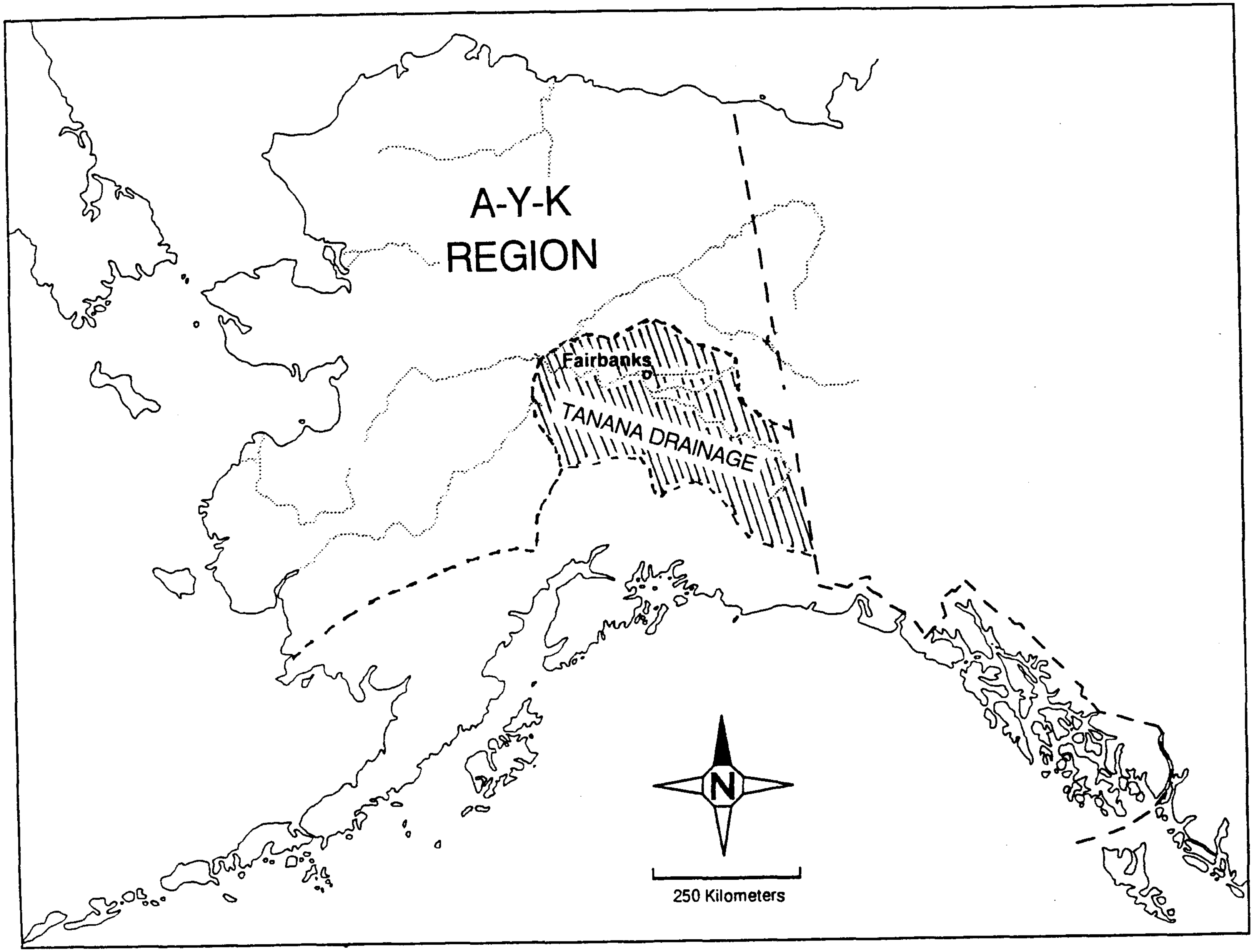

Figure 1. Map of Arctic-Yukon-Kuskokwim (AYK) Region and Tanana River drainage, Alaska.

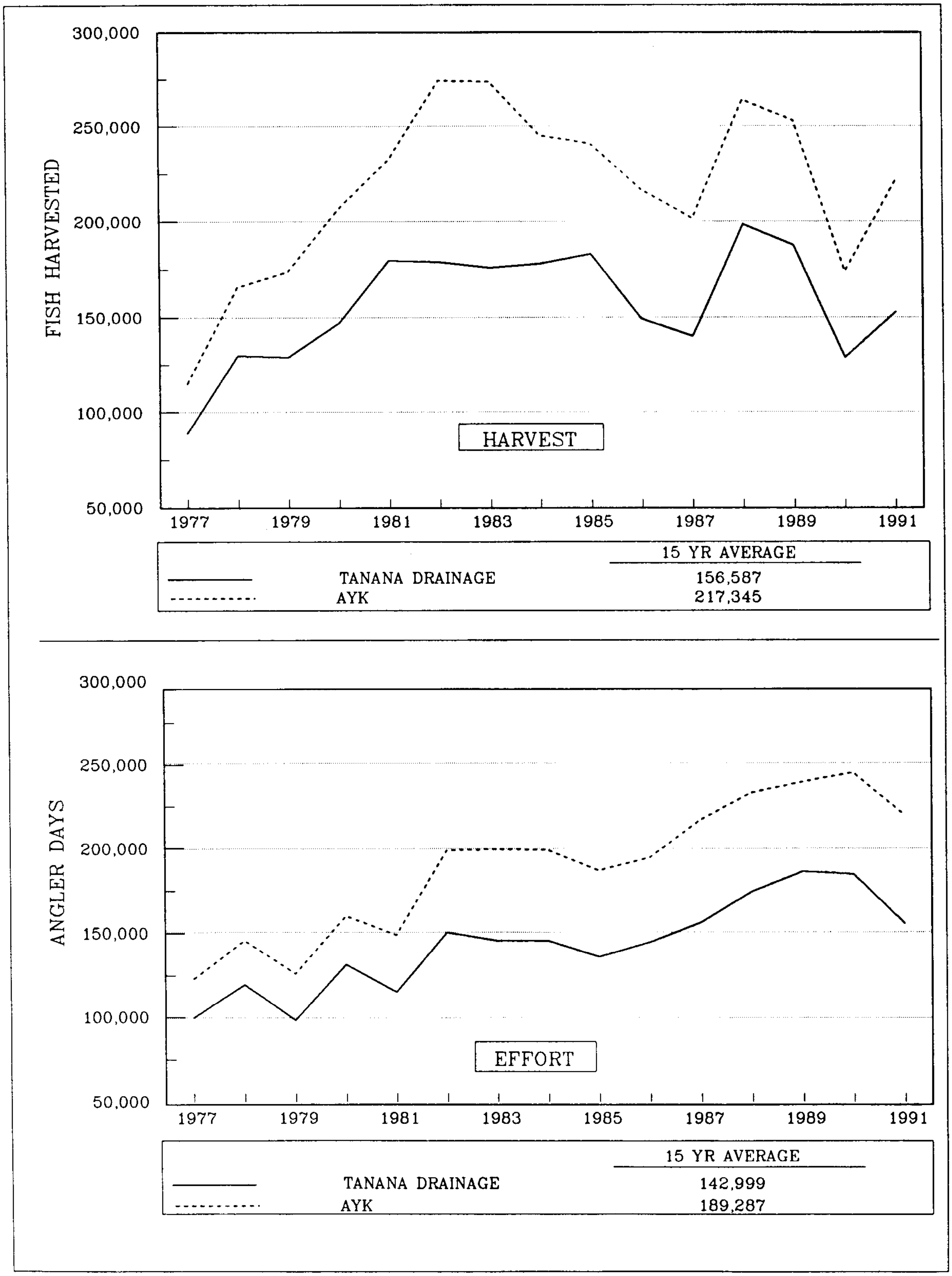

Figure 2. Effort and harvest by recreational anglers in the AYK Region (includes Tanana River drainage) and Tanana River drainage sport fish management areas, 1977-1991.

The long term goals of the creel survey program are to: (1) develop historical data bases to allow monitoring of both the recreational fisheries and the exploited fish populations; (2) develop regulations that reflect the desires of the angling public while ensuring sustained yield of the resource; and (3) estimate the effects of management regulations on the fisheries, fish populations, and recreational angling public.

A comprehensive analysis of the creel surveys that were conducted by the Alaska Department of Fish and Game (ADF&G) in the AYK Region during 1992 is presented in this report.

SALCHA RIVER CHINOOK SALMON FISHERY

Creel surveys were scheduled to be conducted at three of the major fisheries within the Tanana River drainage. However, the Salcha River chinook salmon fishery was closed by a Department Emergency Order due to the poor return of spawning chinook salmon to the Salcha River. The creel survey for this fishery began on 10 July and was cancelled when the fishery was closed by Emergency Order on 24 July 1992. The specific objectives of the Salcha River creel survey were to: 1) estimate the angler effort, and the catch and harvest of chinook salmon; and, 2) to provide information concerning the angler characteristics (e.g., sex, age and residency). During the period when the fishery was monitored, sampling occurred on 11 of the possible 14 days. Interviews were obtained from a total of 278 anglers who had completed their fishing trip and were exiting the area. The creel technician documented one chinook salmon being harvested during this time. Because the fishery was closed by Emergency Order, and so little useful information was obtained from the data collected, the results of the Salcha River chinook salmon creel survey are summarized in Appendix A1. The methods used in the data analysis are the same as those used to estimate the catch, harvest, and effort of chinook salmon in the 1991 Salcha River fishery (Hallberg and Bingham 1992).

CHATANIKA RIVER WHITEFISH SPEAR FISHERY

Introduction

The Chatanika River supports a fall spawning run of least cisco and humpback whitefish. Because of its proximity to Fairbanks and the large size of this spawning run, a whitefish spear fishery has developed at the Chatanika River. In 1987, this fishery accounted for over 90% of the whitefish harvest in the Tanana River drainage and over 75% of the Statewide whitefish harvest (Mills 1988). Most of the whitefish harvested during the Chatanika River spear fishery are least cisco and humpback whitefish. A few round whitefish are harvested along with incidental spearing of sheefish, Arctic grayling, burbot, and longnose suckers *Catostomus catostomus*.

The whitefish recreational spear fishery in the Tanana River drainage began in 1969. Historically, whitefish were pursued by recreational anglers with conventional rod and reel. However, because of the difficulty of catching whitefish on rod and reel, these users began to seek other means of harvesting whitefish. The result was the establishment of a spear fishing season for whitefish within the Tanana River drainage. The spear fishery on the Chatanika River developed rather slowly. A creel survey in 1970 estimated a harvest of 400 whitefish (Hallberg 1985). Estimates of harvest from 1972-1977 averaged around 2,000 whitefish. Harvest continued to increase in the early 1980's and by 1985 more than 14,000 whitefish were reported taken in the Chatanika River (Mills 1986).

Concern over this rapidly expanding fishery and potential effects on the stock status of whitefish prompted ADF&G to initiate an in-depth research project in 1986 that has continued through 1992. The goal of this research was to estimate population abundance, harvest levels, species composition of the runs, and exploitation rates of whitefish in the spear fishery. Part of this research was a creel survey that provided information on angler-effort, harvest, and harvest-per-unit-effort (HPUE). Since 1988, age and length composition data for the harvest have been obtained during mark-recapture experiments conducted prior to the creel survey. It was found that composition data did not significantly differ between that observed during mark-recapture experiments and in the creel survey.

In 1986, the estimated harvest of whitefish was 19,686 fish, with estimated exploitation rates of 23% and 17% for least cisco and humpback whitefish, respectively (Clark and Ridder 1987, Hallberg and Holmes 1987). In 1987, an on-site creel survey estimated harvest at 28,591 whitefish, with exploitation rates estimated to be 43% for least cisco and 17% for humpback whitefish (Hallberg 1988, Baker 1988). This made the Chatanika River the fastest growing recreational fishery in the Tanana River drainage. Because of the high exploitation rates in 1986 and 1987, a 15 whitefish daily bag and possession limit was instituted in 1988. Prior to 1988, there was no bag and possession limit for whitefish in the Tanana River drainage. Harvest of whitefish from the Chatanika River in 1988 was substantially reduced (about 8,000 reported in Mills 1989) by the imposition of possession limits by the Board of Fisheries. In 1989 the harvest of whitefish nearly doubled to 15,542 (Mills 1990). In 1990 the spear fishery was closed by Emergency Order on 10 October, when it was determined that whitefish abundance, harvest and recruitment had declined.

Poor recruitment as result of weak year classes along with dramatic decreases in abundance for both humpback whitefish and least cisco, led to the decision to once again close the spear fishery on 9 September 1991.

During a meeting of the Alaska Board of Fisheries in February of 1992, the time of year and the area of the Chatanika River open to the consumptive harvest of whitefish was made more restrictive. This was done to protect whitefish stocks in the Chatanika River from overharvest and to avoid future inseason "emergency closures" of the fishery.

The ADF&G developed a Chatanika River Sport Fishery Management Plan which identified criteria to allow a consumptive whitefish fishery to occur while not jeopardizing sustainable yields. The plan identifies a threshold population abundance of 10,000 humpback whitefish and 40,000 least cisco. These minimum abundance levels must be present annually before a spear fishery can occur. Based upon population dynamic modeling conducted by ADF&G staff, annual exploitation levels of 15% and 25% for humpback whitefish and least cisco, respectively, are not to be exceeded to insure sustained harvest of the resource. Stock assessment of Chatanika River whitefish are done annually and will provide estimates of abundance. On-site creel surveys will also be conducted annually to monitor the harvest of whitefish.

The specific objectives of the 1992 creel survey at the Chatanika River whitefish spear fishery were to estimate:

1. the harvest of least cisco and humpback whitefish in the Chatanika River whitefish spear fishery, such that the final post-season estimates are within $\pm$ 15% of the true value 95% of the time;

2. the distribution of harvest of whitefish by angler trip in the Chatanika River whitefish spear fishery; and

3. the percent composition within the following demographic categories of anglers interviewed at the Chatanika River:

   a) male/female;
   b) adult/youth;
   c) resident/non-resident;
   d) local/non-local, and
   e) military/non-military.

Study Design

The creel survey in 1992 was conducted at two locations: a State campground and boat launch where the Elliott Highway Bridge crosses the Chatanika River, and at the entrance to the Olnes pond campground (Figure 3). Most anglers enter and exit the fishery from these two locations. The major portion of the fishery is confined to a 5 km section of the river near these two sites. The majority of the fishing is from shore. There is a small amount of effort from boat anglers.

The spear fishery officially opened on 1 September, and occurred from 2000 to 0200 hours; this is the defined fishing day. Historical data indicates that spearing activity and harvest of whitefish actually begins around mid-September. For this reason, the creel survey at the Chatanika River in 1992 began on 18 September. The fishery was closed by regulation on 30 September. The creel survey was terminated on 26 September since the cumulative inseason harvest estimates to that date indicated that the allowable exploitation levels as recommended in the draft fishery management plan would not be reached prior to the end of the fishery on 30 September. The sample period for the fishery was six hours in duration during each day.

Because the potential for overharvest of whitefish stocks in the Chatanika River spear fishery exists, each sampling period within each day during the survey period was censused at both sample locations.

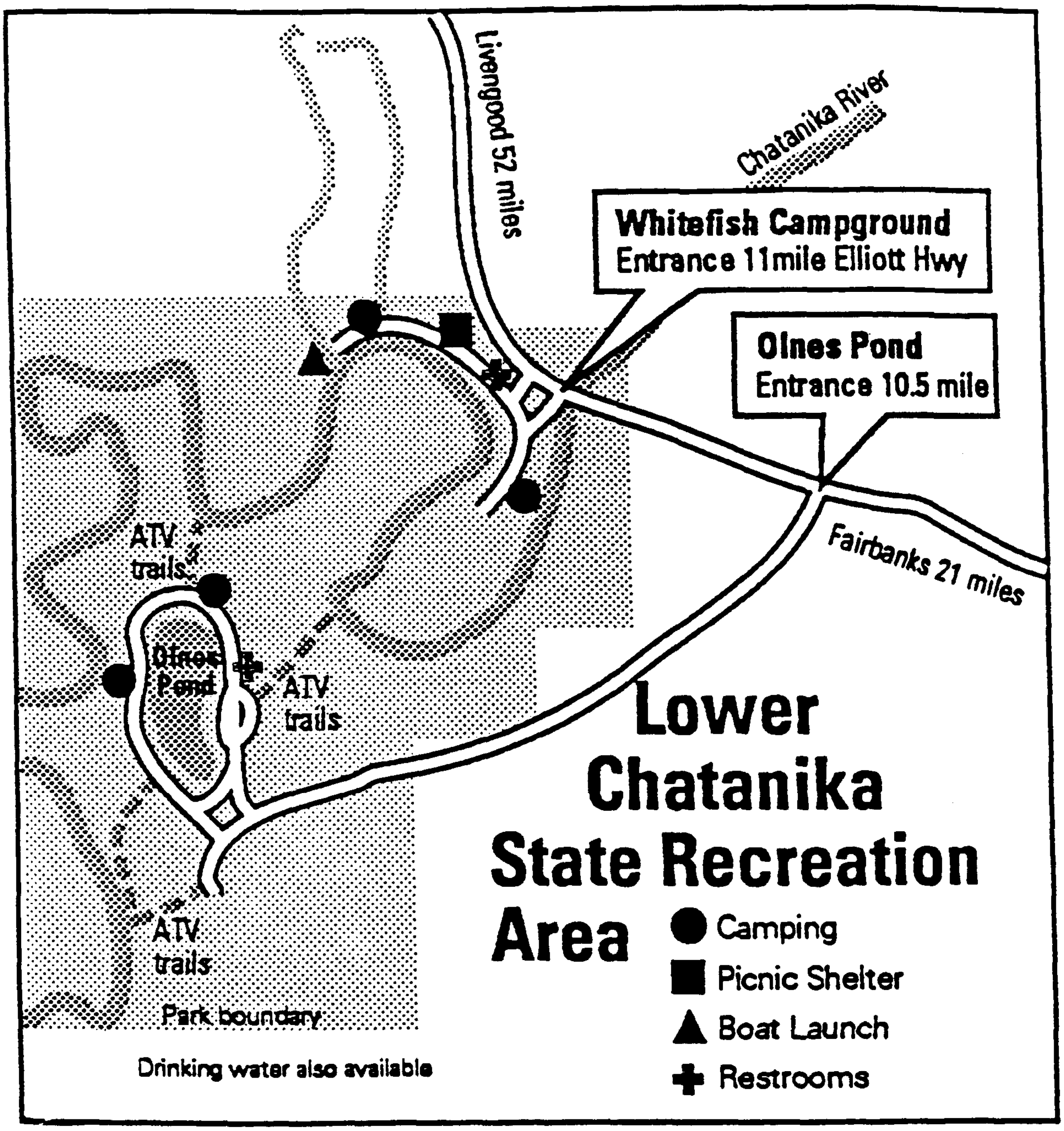

Figure 3. Map of the Elliott Campground, Olnes Pond and Steese Highway areas, Chatanika River, Tanana River drainage, Alaska.

The survey was a direct expansion completed-trip type of survey. The sampling design was of the stratified single-stage type. The strata consisted of each day at each of the two access locations sampled (for a total of 16 strata over the 8 day survey). Within each stratum (day-location combination), vehicle parties[1] exiting the fishery represented the first-stage sampling units. Creel technicians attempted to stop all exiting vehicles. All "missed" vehicle parties were counted. All stopped vehicle parties were interviewed, and their spear fishing effort (in hours) and harvest by species were recorded. For estimation of harvest, individual spearfisher information was not necessary[2], however information on harvest by species was separately recorded by individual in each vehicle party for use in estimating distribution of harvests by fisher-trip. Additionally, individual fisher information was needed for estimation of angler demographics. Information from parties who had not been fishing was recorded, since the mean harvest over all parties stopped and interviewed needed to be estimated to expand for the vehicle parties that were not stopped. Every attempt was made to stop all vehicle parties regardless of whether or not the party had been fishing.

Data Collection

The creel survey at the Chatanika River in 1992 emphasized the collection of harvest and effort information from completed-trip vehicle party interviews. Daily inseason estimates of harvest were obtained, to facilitate any inseason management actions that may have been required.

During each interview, the following information was collected from individual fishers:

1) hours spent fishing;
2) the number of whitefish harvested, by species;
3) fisher gender (male/female);
4) age class (youth 16 years or less/adult);
5) resident or non-resident; and
6) military or non-military.

Local/nonlocal information was not requested because resident/nonresident data were sufficient. All interview data were recorded on to ADF&G Angler Interview Form version 1.1, mark-sense forms.

Data Analysis

Harvest Estimates:

Estimation of the harvest of whitefish by species for each location and day in the fishery involved the direct expansion of sampled interview data by an expansion factor dependent upon the number of vehicle parties "missed" (first-stage units). The following procedures were used to estimate harvest (by species):

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1 A vehicle party was defined as all anglers leaving the fishery in one car or truck.

2 Harvest of the entire party was needed.

$\hat{H}_i$ = estimated harvest exiting the fishery during stratum (location-day *i*);

$$= V_i \bar{n}_i \; ; \qquad (1)$$

V_i equaled the number of vehicle parties counted exiting the fishery during location-day *i* (including both interviewed and "missed" vehicle parties);

$\bar{n}_i$ = mean harvest by all exiting vehicle parties interviewed during location-day *i*;

$$= \frac{\sum_{j=1}^{v_i} n_{ij}}{v_i} \; ; \qquad (2)$$

v_i equaled the number of exiting vehicle parties interviewed during location-day *i*; and n_{ij} is the harvest by interviewed vehicle party *j* during location-day *i*; which included harvest by all "anglers" within each party (sum of harvest over all individuals in the party)[3].

The variance for the estimated harvest for stratum *i* was obtained by the single-stage variance equation (Cochran 1977):

$$\hat{V}[\hat{N}_i] = \left\{ (1 - f_{1i}) \, V_i^2 \, \frac{s_{1i}^2}{v_i} \right\} \qquad (3)$$

where: f_{1i} equaled the first stage sampling fraction (i.e., $f_{1i} = v_i / V_i$);

s_{1i}^2 = the within location-day variance for the harvest estimate observed over all vehicle parties interviewed during each location-day *i*;

$$= \frac{\sum_{j=1}^{v_i} (n_{ij} - \bar{n}_i)^2}{v_i - 1} \, . \qquad (4)$$

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[3] Information from parties that did not fish was also included in estimation, so that the mean harvest over stopped parties could be correctly expanded for all parties.

Total harvest across all location-day strata (or select combinations of strata) and the associated variances was obtained by summing the respective stratum estimates (assuming independence). Standard errors were obtained by taking the square root of the variance estimates.

Harvest Distribution Estimates:

The distribution of harvests for the fishery were estimated as described in the following text. The "distribution of harvests" was defined as the fraction p_k of angler-trips in which "k" or more fish were caught, then "k" can be expressed as k = 1 to k_{max}. If k_{max} = 16, then one set of data was analyzed 16 times to obtain all possible fractions p_k in a set. Although this approach is computationally "intensive", all pertinent statistics will have been calculated. Besides the k_{max} iterations, there was stratification. For each iteration from 1 to k_{max}, there were calculations for each stratum. Additionally, the harvest distribution for k = 0 was defined to be the proportion of fisher-trips that resulted in the harvest of no whitefish.

The value of k_{max} was set to 16 fish for the harvest of all species combined, since the 1992 regulations limited the harvest of these fish in the Chatanika River to 15 per day per fisher[4].

The first step was to code the data prior to calculation. Note, that although the survey was designed as a stratified single-stage sample survey, the harvest information was treated as a two-stage design, in order to get information on an fisher by fisher basis. The coding was as follows:

$$y_{kijo} = \begin{cases} 1 & \text{if harvest made by interviewed fisher } o \text{ within vehicle party } j \text{ in location-day } i \text{ caught k or more fish (or zero fish if k = 0);} \\ 0 & \text{otherwise.} \end{cases} \qquad (5)^5$$

The fisher met the criterion if his or her harvest $n_{ijo} \geq k$ where k = 1 to kmax or $n_{ijo} = 0$ for k = 0; otherwise $y_{kijo} = 0$. The data was recoded for each iteration from 0 to kmax. After coding, the average fraction and its variance were found for each stratum:

[4] Such that the harvest distribution for k = 16, described the proportion of fishers who exceeded the bag limit.

[5] Including data from only individuals who reported fishing.

$\bar{\bar{y}}_{ki}$ = proportion of fisher-trips in location-day *i* that harvested 0 or at least k fish;

$$= \frac{\sum_{j=1}^{v_i^*} \bar{y}_{kij}}{v_i^*} \; ; \qquad (6)^{6}$$

where:

v_i^* was the restricted number of vehicle parties stopped and interviewed within each location-day, restricted to those vehicle parties with at least one fisher per car.

$\bar{y}_{kij}$ = proportion of fisher-trips within each vehicle party on location-day *i* that harvest 0 or at least k fish;

$$= \frac{\sum_{o=1}^{M_{ij}} y_{kijo}}{M_{ij}} \; ; \qquad (7)$$

M_{ij} equaled the number of fishers interviewed within each vehicle party[7]; and all other terms were as defined above.

The variance of the estimated proportion was obtained by the usual single-stage equation[8]:

$$\hat{V}[\bar{\bar{y}}_{ki}] = \left\{ (1 - f_{1i}) \frac{s_{1ki}^2}{v_i} \right\} \qquad (8)$$

---

[6] Including data from only vehicle parties with at least one individual who reported fishing.

[7] Including only individuals that reported fishing (note that all individuals within each party were interviewed).

[8] No second stage variance component was needed for this estimation, since all fishers within a vehicle party were interviewed.

where:

s^2_{1kh} = sample variance among primary units;

$$= \frac{\sum_{j=1}^{v_i^*} (\bar{y}_{kij} - \bar{\bar{y}}_{ki})^2}{v_i^* - 1} ; \qquad (9)^9$$

and all other terms were as defined above.

Once the estimated proportion and its variances were calculated for all strata in an iteration, the statistics were combined as weighted averages to estimate one set of statistics (p_k's) of harvest distribution for the entire fishery (following the procedures explained in Cochran 1977, Equation 10.45, page 288):

$\hat{p}_k$ = the estimated fraction of completed fisher-trips in which fishers harvest either 0 or at least k whitefish;

$$= \sum_{i=1}^{s} \hat{W}_i \bar{\bar{y}}_{ki} ; \qquad (10)$$

$\hat{V}[\hat{p}_k]$ = variance estimate, using Goodman's (1960) formula;

$$\approx \sum_{i=1}^{s} \left\{ \hat{W}_i^2 \hat{V}[\bar{\bar{y}}_{ki}] + \bar{\bar{y}}_{ki}^2 \hat{V}[\hat{W}_i] - \hat{V}[\bar{\bar{y}}_{ki}] \hat{V}[\hat{W}_i] \right\} ; \qquad (11)$$

where:

$\hat{W}_i$ = estimated relative stratum weight of stratum *i* (equivalent to the ratio of the estimated number of fisher-trips for the stratum compared to the total number of fisher-trips);

$$= \frac{\hat{M}_i}{\hat{M}} ; \qquad (12)$$

9 Including data from only vehicle parties with at least one individual who reported fishing.

$\hat{M}$ equaled the total estimated number of fisher-trips participating in the fishery (equal to the sum of fisher-trips across all strata);

$\hat{M}_i$ = estimated number of fisher-trips participating in the fishery within stratum i;

$$= V_i \bar{M}_i \; ; \tag{13}$$

$\bar{M}_i$ = mean number of fisher-trips within each location-day;

$$= \frac{\sum_{j=1}^{v_i} M_{ij}}{v_i} \; ; \tag{14}$$

[10]

$\hat{V}[\hat{W}_i]$ = estimated variance of the estimated stratum weight, obtained approximately, via the Delta method;

$$\approx \left\{ \frac{\hat{M}_i}{\hat{M}} \right\}^2 \left\{ \frac{\hat{V}[\hat{M}_i]}{\hat{M}_i^2} + \frac{\hat{V}[\hat{M}]}{\hat{M}^2} - \frac{2\,\hat{V}[\hat{M}_i]}{\hat{M}_i\,\hat{M}} \right\} ; \tag{15}$$

$\hat{V}[\hat{M}_i]$ = estimated variance of the estimated number of fisher-trips per stratum, obtained from the standard single-stage direct expansion variance equation;

$$= (1 - f_{1i}) \frac{V_i^2}{v_i} \frac{\sum_{j=1}^{v_i} (M_{ij} - \bar{M}_i)^2}{(v_i - 1)} \; ; \tag{16}$$

and all other terms were as defined above.

Standard errors were obtained by taking the square root of the variance estimates.

Angler demographics:

Estimates of each proportion associated with each parameter (e.g., various angler demographic categories) were calculated according to the following procedures:

[10] Note, that this calculation was performed over all vehicle parties stopped and interviewed, i.e., including even parties with no anglers. Accordingly, zero anglers within a vehicle party was included in calculating this mean value.

$\hat{p}_{ui}$ = estimated proportion of the fisher-trips that were category u[11] within stratum i;

$$= \frac{\sum_{j=1}^{v_i^*} \hat{p}_{uij}}{v_i^*} ; \qquad (17)$$

$\hat{p}_{uij}$ = estimated fraction of fisher-trips categorized as "type u" (dependent upon parameter being estimated) within each stopped and interviewed vehicle party (utilizing only vehicles with individuals who fished);

$$= \frac{M_{uij}}{M'_{ij}} ; \qquad (18)$$

M_{uij} = number of fishers categorized as "type u" within each vehicle party; and,

M'_i = number of fishers interviewed within each vehicle party, which can be categorized (i.e., does not include fishers who do not respond to particular question of interest).

The variance of the estimate of stratum estimate of each proportion (for each parameter) was obtained using a single-stage equation[12]:

$$\hat{V}[\hat{p}_{ui}] = \left\{ (1-f_{1i}) \frac{s_{1i}^2}{v_i} \right\} ; \qquad (19)$$

s_{1h}^2 = within location-day variance for the estimated proportion;

$$= \frac{\sum_{j=1}^{v_i^*} (\hat{p}_{uij} - \hat{p}_{ui})^2}{v_i^* - 1} ; \qquad (20)$$

and all other terms were as defined above.

---

11 Where category referred to the different classifications, dependent upon the parameter being estimated.

12 No second stage variance component was needed for this estimation, since all fishers within a vehicle party were interviewed.

The estimated proportion by category and its variance (across all strata) was obtained by the following procedures. The individual stratum estimates of proportions by category were weighted by the relative size of each stratum in terms of the estimated number of fisher-trips, as follows:

$\hat{p}_u$ = estimated proportion of the fisher-trips that are category *u* in the fishery (across sampling strata);

$$= \sum_{i=1}^{s} \hat{W}_i \hat{p}_{ui}; \tag{21}$$

where: $\hat{W}_i$ equaled the estimated relative stratum weight of stratum *i* (see equation 12).

The variance of the across stratum proportional estimate by category was obtained using Goodman's (1960) formula:

$$\hat{V}[\hat{p}_u] \approx \sum_{i=1}^{s} \left\{ \hat{W}_i^2 \hat{V}[\hat{p}_{ui}] + \hat{p}_{ui}^2 \hat{V}[\hat{W}_i] - \hat{V}[\hat{p}_{ui}] \hat{V}[\hat{W}_i] \right\}; \tag{22}$$

where: all terms were as defined above.

Standard errors were obtained by taking the square root of the variance estimates.

Assumptions:

The general assumptions necessary for unbiased point and variance estimates of harvest, obtained by the procedures outlined above were:

1. no significant fishing effort occurred during the hours not included in the fishing day; and

2. all fishers participating in the defined fishery exited the fishery through the surveyed access sites.

Similarly, unbiased point and variance estimates of angler demographics depended upon the validity of the above assumptions as well as the following additional assumption:

3. creel clerks accurately classified fishers and the interviewed fishers accurately reported their demographic characteristics.

As noted above, information from previous surveys indicated that virtually all fishers exit the fishery at the surveyed location, between the hours of 2000 and 0200. The creel clerk as well as the project leader periodically evaluated the exit patterns of the fishery to ensure that the first two assumptions were valid for the 1992 survey.

There was no direct way of evaluating or testing the third assumption. Fishers were expected to accurately report their demographic characteristics.

Since no attempt was made to correct for avidity bias, then the estimates of angler demographics and opinion only relate to the proportion of fisher-trips not to the proportion of individual fishers.

Results

By early September, 1992, the whitefish research stock assessment program had completed its abundance estimates for least cisco and humpback whitefish in the Chatanika River (Fleming and Schisler *in press*). The study indicated that there were approximately 91,200 least cisco and 21,400 humpback whitefish spawners, present in the Chatanika River at that time. Since number of both species in 1992 exceeded the defined threshold abundance levels, the fishery was allowed to proceed. Based upon these abundance estimates, ADF&G was prepared to hold the harvest of least cisco and humpback whitefish to 22,000 and 3,200, respectively. These harvests represent the maximum number of each species that can be taken, and still remain within the recommended ranges of exploitation.

Because historical records indicate that spearing activity and harvest of whitefish begins around mid-September, the harvest survey began on 18 September and was terminated on 26 September. By 26 September it had become apparent that the cumulative inseason harvest of both species, along with the anticipated harvest for the remainder of the season, would indeed be well below the allowable exploitation levels as identified in the fishery management plan.

During the 1992 creel survey 484 interviews were obtained from fishers who had completed their fishing trip and were exiting the fishery at one of two areas. Fishers expended a total of 1,239 (SE = 16) hours of spear fishing to harvest a total of 1,898 (SE = 49) least cisco, and 392 (SE = 9) humpback whitefish (Table 1).

Approximately 62% (SE = 1.3) of all anglers harvested at least one or more whitefish (Table 2). The distribution of whitefish harvests among fishers interviewed shows that about 38% of the fishers harvested no whitefish (Figure 4).

Of the fishers interviewed at the Chatanika River, the typical fisher was male (82%, SE = 1), adult (95%, SE = 1), a resident of Alaska (99%, SE = <5), and non-military (88%, SE = 1; Table 3).

Discussion

The Department was concerned that fishers would respond to the new regulations (effective in 1992) that restricted both the area open to fishing for whitefish and the season, by going earlier in the season (prior to mid September). With this in mind, staff conducted four (spot check) surveys of the fishery before the scheduled creel census begin on 18 September. No appreciable effort was documented during these visits and

Table 1. Individual stratum with daily and cumulative estimates of effort for and harvest of least cisco and humpback whitefish in the 1992 Chatanika River whitefish spear fishery from 18 to 26 September.

Date	Number of Vehicle-Parties Interviewed	Number of Vehicle-Parties Leaving the site	Number of Spearfishers per Vehicle-Party Interviewed	Estimated Number of Hours Fishing	SE	Estimated Harvest of Least Cisco	SE	Estimated Harvest of Humpback Whitefish	SE
SITE=Whitefish CG									
18 SEP	5	8	10	33	4	0	0	2	1
19 SEP	8	11	15	41	5	0	0	3	1
20 SEP	0	0	0	0	0	0	0	0	0
21 SEP	2	2	4	7	0	10	0	2	0
22 SEP	3	3	4	7	0	16	0	2	0
23 SEP	5	5	7	11	0	9	0	7	0
24 SEP	16	16	25	52	0	27	0	19	0
25 SEP	18	21	30	55	4	13	3	12	2
26 SEP	32	39	53	129	7	1	1	9	3
Subtotal	89	105	148	335	10	76	3	56	4
SITE=Olnes Pond									
18 SEP	3	6	8	33	5	106	41	6	2
19 SEP	20	22	42	96	5	182	12	12	2
20 SEP	9	9	20	55	0	145	0	17	0
21 SEP	10	11	20	59	3	211	6	32	2
22 SEP	9	9	19	59	0	177	0	35	0
23 SEP	15	16	37	75	3	220	11	13	1
24 SEP	18	18	35	83	0	127	0	37	0
25 SEP	37	40	85	251	8	365	20	109	8
26 SEP	32	32	70	193	0	289	0	75	0
Subtotal	153	163	336	904	12	1,822	49	336	8
Total	242	268	484	1,239	16	1,898	49	392	9

Date	Estimated Number of Hours Fishing	SE	Cumulative Estimated Number of Hours Fishing	SE	Estimated Harvest of Least Cisco	SE	Cumulative Estimated Harvest of Least Cisco	SE	Estimated Harvest of Humpback Whitefish	SE	Cumulative Estimated Harvest of Humpback Whitefish	SE
Both Sites Combined												
18 SEP	66	7	66	7	106	41	106	41	8	3	8	3
19 SEP	137	7	203	9	182	12	288	43	15	2	23	3
20 SEP	55	0	258	9	145	0	433	43	17	0	40	3
21 SEP	66	3	324	10	221	6	654	43	34	2	74	4
22 SEP	66	0	390	10	193	0	847	43	37	0	111	4
23 SEP	86	3	476	11	229	11	1,075	45	20	1	131	4
24 SEP	135	0	611	11	154	0	1,229	45	56	0	187	4
25 SEP	306	9	917	14	378	20	1,608	49	121	8	308	9
26 SEP	322	7	1,239	16	290	1	1,898	49	84	3	392	9

Table 2. Estimates of harvest distribution for the 1992 Chatanika River whitefish spear fishery from 18 to 26 September.

Number of Whitefish	Proportion of Trips With Noted Harvest of Whitefish	SE	Proportion of Trips With At Least the Noted Harvest of Whitefish	SE
0	38.1%	1.1%	---	---
1	8.3%	0.4%	61.9%	1.3%
2	5.7%	0.3%	53.7%	1.3%
3	4.4%	0.3%	47.9%	1.3%
4	4.5%	0.4%	43.5%	1.2%
5	6.2%	0.3%	39.1%	1.1%
6	3.8%	0.4%	32.9%	1.0%
7	1.7%	0.1%	29.1%	1.0%
8	3.9%	0.4%	27.4%	1.0%
9	2.4%	0.4%	23.4%	0.9%
10	4.5%	0.4%	21.0%	0.6%
11	0.7%	0.0%	16.5%	0.4%
12	3.4%	0.2%	15.8%	0.4%
13	3.1%	0.2%	12.4%	0.4%
14	1.3%	0.1%	9.3%	0.3%
15	7.8%	0.3%	8.0%	0.3%
16	0.2%	0.1%	0.2%	0.1%

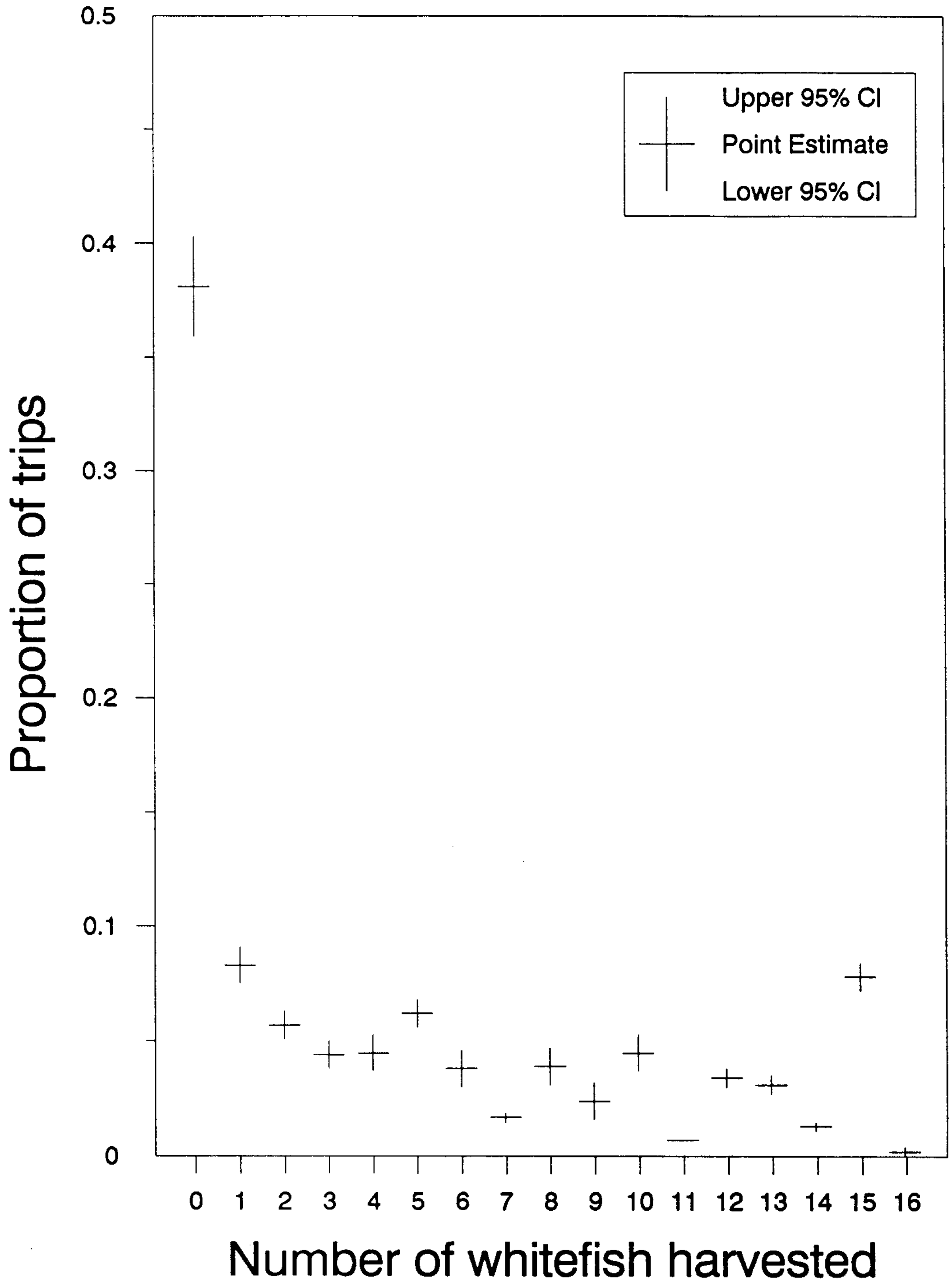

Figure 4. Distribution of whitefish harvest among fishers interviewed at the Chatanika River, Tanana River drainage, Alaska, 18 to 26 September 1992.

Table 3. Estimated proportion of trips by various demographic categories for the 1992 Chatanika River whitefish spear fishery from 18 to 26 September, with the estimated number of trips equal to 518 (SE = 9).

	Number Interviewed	Proportion[a]	SE[b]
Male	376	0.82	0.01
Female	92	0.18	0.01
Youth	31	0.05	0.01
Adult	437	0.95	0.01
Resident	463	0.99	0.01
Non-resident	5	0.01	<0.005
Local	456	0.98	0.01
Non-local	12	0.02	<0.005
Military	56	0.12	0.01
Non-Military	412	0.88	0.01

[a] Proportions are weighted by stratum weights.
[b] Standard error of the weighted proportion.

participation in the fishery did not begin to intensify until around the 20th of September.

The majority (69%) of the interviews were obtained at the Olnes Pond area, and 73% of the fishing effort and 96% of the harvest of all whitefish occurred here.

Nearly 8% of the fishers achieved the legal bag limit of 15 whitefish, some fishers interviewed (less than 1%) had harvested more than the legal bag limit.

While the effect of bag limits (imposed beginning in the fall of 1988) resulted in a temporary reduction in the take of whitefish, harvest began increasing in 1989 because anglers took more fishing trips. During the 1992 spear season fishing effort and harvest at both the Whitefish Campground and Olnes Pond areas were steadily increasing up to 26 September when the creel survey was terminated. Had the new regulation not been in effect, it appears that whitefish populations in the Chatanika River would once again have been subject to excessive harvest. The current regulation, coupled with the management strategies outlined in the Chatanika River Sport Fishery Management Plan, should provide for continued fishing opportunity in the future, without emergency actions by the Department.

FIELDING LAKE ARCTIC GRAYLING FISHERY

Introduction

Traditional methods of fish stock assessment require that attributes of the stock be measured (e.g., length, weight, age) so that an acceptable level of yield or harvest can be computed. One such expression of yield is the yield-per-recruit model of Beverton and Holt (1957). Their model expresses yield as a function of weight harvested per individual fish that recruits to the fishery. In most situations, recreational fisheries are not managed to maximize the yield in weight from the stock. Moreover, anglers have particular attitudes or levels of satisfaction towards the sizes of fish they harvest. In an effort to incorporate the concept of satisfaction into fish stock assessment, Die et al. (1988) have replaced the term "yield-per-recruit" with "utility-per-recruit." Utility-per-recruit analysis replaces yield in weight with yield in satisfaction (one measure of utility) in the calculations. From these calculations, managers can regulate a fishery to either maximize or increase angler satisfaction instead of maximizing or increasing fish weight in the harvest of recreational fisheries.

The concept of utility is new to fisheries research and very little angler satisfaction data are available. In addition, aspects of population dynamics such as fishing and natural mortality rates of fish stocks in interior Alaska are not well understood. In an attempt to experiment with the usefulness of utility-per-recruit modeling, the Arctic grayling fishery in Fielding Lake was chosen for analysis. The population dynamics of Arctic grayling in Fielding Lake is presently being researched (see Clark 1991) and there is no length limit restriction on this stock. Anglers' level of satisfaction with the sizes of fish they harvested from the lake was collected, and coupled with population data, utility-per-recruit of this stock was analyzed.

The research objectives for 1992 were to estimate:

1) the distribution of satisfaction ratings of Arctic grayling harvested by anglers in each of the Relative Stock Density (RSD) categories (see Gabelhouse 1984); and,

2) the distribution of satisfaction ratings of Arctic grayling harvested by anglers in each age class.

Study Design

The creel survey in 1992 was conducted at the State campground and boat launch facility at Fielding Lake (Figure 5). Most anglers either fish for Arctic grayling from shore along the outlet stream, Phalen Creek, or launch their boat along the lake margins. While fishing at Fielding Lake is open year around, most anglers target Arctic grayling immediately after ice out, which usually occurs around mid-April.

The primary sampling unit for the Fielding Lake survey was the individual angler. On each allotted day, the creel clerk contacted anglers who have finished fishing, interviewed them, and sampled their creels. To optimize the contact of anglers exiting the fishery, the creel clerk attempts to interview anglers between 1100 hours and 2000 hours (averaging 36 hours per week), on every Friday through Monday, from 15 June through 17 July.

Data Collection

The interview began by asking the angler to individually rate each of the Arctic grayling in their creel. The angler was asked to rate their catch on a five-point scale, indicating to the angler only that a rating of five (5) would be considered a "trophy" fish and a rating of one (1) would imply that any less satisfying fish would have been released. Each fish was measured for length, a scale sample taken, and the corresponding rating recorded. The angler was then asked to rate their overall creel of Arctic grayling. The same five-point scale was used for rating the entire creel. The angler was also asked to provide the following information: time spent fishing, target species, and the number of Arctic grayling kept.

All interview date were recorded on to ADF&G Tagging Length Form version 1.0 mark-sense forms.

Data Analysis

Standard procedures for estimating proportions (see Cochran 1977) were followed to estimate the proportional distribution of the various satisfaction ratings of individual fish within the following Gabelhouse (1984) categories for Arctic grayling: "small" = $\leq$ 149mm, "stock" = 150mm - 269mm, "quality" = 270mm - 339mm, "preferred" = 340mm - 449mm, "memorable" = 450mm - 559mm, and "trophy" = $\geq$ 560mm (see Gabelhouse 1984). Elementary exploratory data analysis (EDA) (see Hoaglin et al. 1983) were followed to

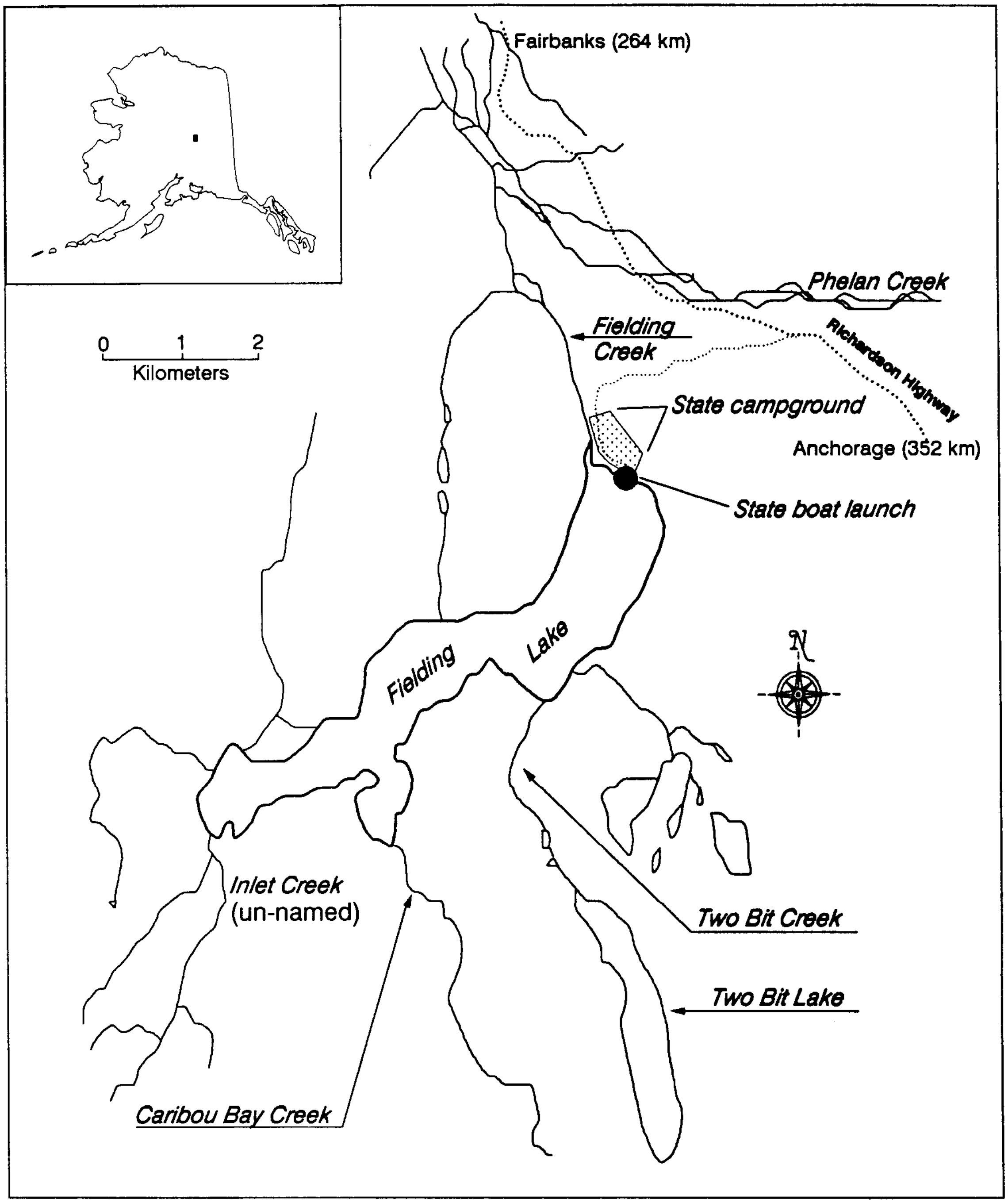

Figure 5. Map of Fielding Lake, Tanana River drainage, Alaska,

investigate possible biases in the estimates (e.g., intra-correlation among ratings by the same angler for different sized/aged fish).

RESULTS AND DISCUSSION

Interviews were obtained from 68 anglers, and 124 Arctic grayling were examined at the Fielding Lake State campground. Forty-one Arctic grayling were of the stock category, 61 and 22 were of the quality and preferred categories, respectively. No memorable or trophy size category Arctic grayling were encountered in the sample. Arctic grayling (n = 107) ranged in ages from age 2 to 7.

Angler ratings generally increased with each increasing RSD category and with increasing age of the Arctic grayling they harvested at Fielding Lake.

Anglers rated their satisfaction with stock size category Arctic grayling harvested at Fielding Lake, from a range of 1 to 4, with a rating of 2 representing the highest percentage of 44% (SE = 8; Table 4).

Anglers rated their satisfaction with quality size category Arctic grayling harvested at Fielding Lake, from a range of 1 to 4, with a rating of 3 representing the highest percentage, 52% (SE = 6; Table 4).

Anglers rated their satisfaction with preferred size category Arctic grayling harvested at Fielding Lake, from a range of 2 to 5, with a rating of 4 representing the highest percentage, 45% (SE = 11; Table 4).

Fifty Percent (SE = 11) of the anglers gave age 3 Arctic grayling a rating of 2 (Table 5). Ages 4 and 5 Arctic grayling were given a rating of 3 by the majority of the anglers, 52% (SE = 8) and 50% (SE = 12) respectively (Table 5). Thirty-eight percent (SE = 14) of the anglers rated their satisfaction with age 6 fish at tour, while age 7 fish were rated from 3 to 5 with the majority 56% (SE = 18) also giving them a rated of 4 (Table 5). Anglers in general appeared to be somewhat satisfied with the Arctic grayling they harvested while fishing at Fielding Lake. Angler ratings did increase with each increasing RSD category as well as with each increasing age class for the Arctic grayling they harvested here.

ACKNOWLEDGEMENTS

We wish to thank the creel technicians Dave Stoller, Renata Riffe, Roy Perry, and Richard Barnes for collecting the survey data and suggesting improvements in procedures. We wish to thank Renata Riffe for her efforts in scale mounting preparations and with the aging of Arctic grayling scales and, Bob Clark for providing the analysis of the Fielding Lake survey and the initial age determination of Arctic grayling. Sara Case is thanked for typing the report. Donna Buchholz and Gail Heineman, of Research and Technical Services, assisted in the processing of the mark-sense data and in archiving all data associated with the project. Thanks to the U.S. Fish and Wildlife Service for the funding of this project through the Federal Aid in Fish Restoration Act (16 U.S. C. 777-777K) under Project F-10-8, Job No. R-3-1.

Table 4. Distribution of angler satisfaction rating by Relative Stock Density category (RSD) of Arctic grayling at Fielding Lake, 19 June through 19 July 1992.

		% Angler satisfaction rating[a]									
RSD[b]	n	1	SE	2	SE	3	SE	4	SE	5	SE
Stock	41	24.0	7.0	44.0	8.0	29.0	7.0	2.0	2.0	0	0
Qual.	61	11.0	4.0	26.0	6.0	52.0	6.0	10.0	4.0	0	0
Pref.	22	0	0	5.0	5.0	32.0	10.0	45.0	11.0	18.0	8.0
Mem.	0										
Trophy	0										
Total	124	14.0	3.0	28.0	4.0	41.0	4.0	14.0	3.0	3.0	2.0

[a] Anglers were asked to rate Arctic grayling that they harvested on a 5-point scale, with a rating of 1 implying the lowest satisfaction and a rating of 5 implying the greatest satisfaction.

[b] RSD categories are: stock - 150 to 269 mm FL; quality - 270 to 339 mm FL; preferred - 340 to 449 mm FL; memorable - 450 to 559 mm FL; and, trophy - greater than 559 mm FL.

Table 5. Distribution of angler satisfaction rating by age of Arctic grayling at Fielding Lake, 19 June through 19 July 1992.

		% Angler satisfaction rating[a]									
Age	n	1	SE	2	SE	3	SE	4	SE	5	SE
2	3	67.0	33.0	0	0	33.0	33.0	0	0	0	0
3	22	27.0	10.0	50.0	11.0	23.0	9.0	0	0	0	0
4	42	10.0	5.0	33.0	7.0	52.0	8.0	5.0	3.0	0	0
5	18	6.0	6.0	22.0	10.0	50.0	12.0	22.0	10.0	0	0
6	13	8.0	8.0	15.0	10.0	31.0	13.0	38.0	14.0	8.0	8.0
≥7	9	0	0	0	0	22.0	15.0	56.0	18.0	22.0	15.0
Total	107	13.0	3.0	29.0	4.0	40.0	5.0	15.0	3.0	3.0	2.0

[a] Anglers were asked to rate Arctic grayling that they harvested on a 5-point scale, with a rating of 1 implying the lowest satisfaction and a rating of 5 implying the greatest satisfaction.

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APPENDIX A

Appendix A1. Estimates of angler effort for and catch and harvest of chinook salmon during the 1992 Salcha River chinook salmon creel survey, 10 to 24 July.

	Number of days sampled	Number of anglers Interviewed	Estimated Angler Effort (hours)	SE	Estimated Catch of Chinook Salmon	SE	Estimated Harvest of Chinook Salmon	SE
Early day[a]	4	59	594	316	4	3	4	3
Late day[b]	7	219	1,226	304	4	3	0	0
Total	11	278	1,820	439	8	4	4	3

[a] 1000 to 1800 hours.
[b] 1800 to 0200 hours.

Appendix A2. Estimates of angler demographics and gear usage for the 1992 Salcha River chinook salmon fishery from 10 to 24 July, with the estimated number of trips equal to 712 (SE = 150).

	Number Interviewed	Proportion	SE
Male	247	0.886	0.171
Female	31	0.114	0.041
Youth	24	0.085	0.023
Adult	254	0.915	0.192
Resident	245	0.888	0.181
Non-resident	33	0.112	0.031
Military	182	0.669	0.154
Non-Military	96	0.331	0.058
Spin Only	236	0.844	0.161
Spin and Bait	42	0.156	0.055

APPENDIX B

Appendix B. Angler interview, angler count, and biological data files developed for creel surveys in interior Alaska in 1992[a].

U0050IA2.DTA	Salcha River chinook salmon fishery, creel survey angler interview data.
U0040IA2.DTA	Chatanika River creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting the Chatanika River at the Whitefish campground.
U004AIA2.DTA	Chatanika River creel survey angler interview data. Interviews with anglers who had completed there fishing trip and were exiting the Chatanika River at Olnes Pond.
U0130LB2.DTA	Fielding Lake Arctic grayling fishery, angler satisfaction survey and Arctic grayling length and age data.